DIET SUPPLEMENTATION WITH 18:0 DOES NOT PROVE USEFUL TO ALLEVIATE FISH-OIL INDUCED MILK FAT DEPRESSION IN DAIRY EWES

P. G. Toral¹, G. Hervás¹, D. Carreño¹, J. S. González¹, J. Amor² and P. Frutos¹

¹Instituto de Ganadería de Montaña (CSIC-ULE), León, Spain ²INATEG, León, Spain
PRACTICAL APPLICATION

Addition of marine lipids to dairy ewe diet

Potentially positive effects on the nutritional value of milk fat (n-3 PUFA, CLA, t11-18:1...)

Negative effects on animal performance

Milk fat depression (MFD)
BIOHYDROGENATION (BH) THEORY
(Bauman and Griinari, 2001)

Under certain dietary conditions, the pathways of rumen BH are altered, producing unique fatty acid intermediates that are potent inhibitors of milk fat synthesis.

MFD due to marine lipids

Other intermediates or mechanisms

Antilipogenic fatty acids $t10c12$, $c10t12$ and $t9c11$-CLA

Alterations of milk fat fluidity?
RUMEN

- c9c12-18:2
- c9c12c15-18:3

MAMMARY GLAND

- c9c12-18:2
- c9c12c15-18:3
- c9c12c15-18:3
- c9c12-18:2
t11c15-18:2

Marine lipids

18:0
Marine lipids

\[ c_{9}d_{12}-18:2 \]
\[ \rightarrow c_{9}d_{11}-18:2 \]
\[ \rightarrow t_{11}-18:1 \]
\[ \rightarrow 18:0 \]

\[ c_{9}d_{12}c_{15}-18:3 \]
\[ \rightarrow c_{9}d_{11}c_{15}-18:3 \]
\[ \rightarrow t_{11}c_{15}-18:2 \]

\[ \rightarrow c_{9}d_{11}-CL\ A\]
RUMEN

\[ c_{9\,12-18:2} \]
\[ \downarrow \]
\[ c_{9\,12-18:2} \]
\[ c_{9\,11-18:2} \]
\[ c_{9\,11-18:2} \]
\[ \downarrow \]
\[ c_{9\,11-18:2} \]
\[ t_{11\,15-18:2} \]
\[ t_{11\,15-18:2} \]

\[ t_{11-18:1} \]

\[ \text{Marine lipids} \]

\[ 18:0 \]

MAMMARY GLAND

\[ c_{9\,12-18:2} \]
\[ c_{9\,12-18:2} \]
\[ c_{9\,12-18:2} \]
\[ c_{9\,12-18:2} \]
\[ c_{9\,11-18:2} \]
\[ c_{9\,11-18:2} \]

\[ t_{11-18:1} \rightarrow c_{9\,11-18:1-CLA} \]

\[ \Delta^9\text{-desaturation} \]

\[ 18:0 \rightarrow c_{9-18:1} \]
$18:0 \ (69^\circ C)$

$\Delta^9$-desaturation

$\textit{cis}-9 \ 18:1 \ (14^\circ C)$

\[
\begin{aligned}
\text{Synthesis of milk TG} \\
\text{with low melting point}
\end{aligned}
\]

Maintenance of milk fat fluidity at body temperature
Marine lipid supplements

\[ \text{Synthesis of milk TG with low melting point} \]

Maintenance of milk fat fluidity at body temperature

MILK FAT DEPRESSION ?

\[ \text{trans 18:1 (40-66°C)} \]

\[ \text{cis-9 18:1 (14°C)} \]

\[ \text{18:0 (69°C)} \]

\[ \Delta^9\text{-desaturation} \]
OBJECTIVE

To test the hypothesis that supplemental 18:0 could contribute to alleviate fish oil-induced MFD in dairy sheep
12 Assaf ewes → 3 lots (n = 4)
3 x 3 Latin square design

3 experimental diets
TMR (F:C ratio 40:60)

- Non supplemented → Control
  +2% fish oil → FO
  +2% fish oil +2% 18:0 → FOSA

3 periods (28 d/period)

- DM intake (lot)
- Milk production (individual)
- Milk fat, protein and lactose % (individual)
- Milk fatty acid profile (lot)
Digestibility of the 18:0 supplement

Period 1
n=3
FO

Period 2
n=3
FOSA

Change-over design

Metabolic cages

0 1 2 3 4 5 6 7 day

Measurements

Intake
Feces

Samplings

Diets
Orts
Feces

% DM
Lipid composition
Milk fatty acid profile

20:5n-3 (EPA)

22:6n-3 (DHA)

22:5n-3 (DPA)

c9,t11-CLA

Control  FO  FOSA
Milk production

![Diagram showing milk production with control, FO, and FOSA groups. The bars are close in height with a note of "ns" indicating no significant difference.]
**Fat**

-20%

**18:0**

Control values could not be attained

- Digestibility coefficient of 18:0 = 48%
- Low mammary uptake
- Other factors that counteract 18:0 supplementation?

**c9-18:1**

↑

18:0 availability did not prove useful to alleviate MFD
Milk fatty acid profile

Ruminal alterations?

Odd- and branched-chain FA

Differences in microbial **diversity** and **activity**?

$t_{10}-18:1$

Shift in **ruminal biohydrogenation** pathways?

$t_{11}-18:1$

MFD?

Control  FO  FOSA

1. Odd- and branched-chain FA
2. $t_{10}-18:1$
3. $t_{11}-18:1$
Candidate milk fat inhibitors

**t9c11-CLA**

- Control: b
- FO: a
- FOSA: a

**10-oxo-18:0**

- Control: c
- FO: a
- FOSA: b

**c11-18:1**

- Control: c
- FO: b
- FOSA: a

**c9-16:1**

- Control: b
- FO: a
- FOSA: a

**Antilipogenic effects in adipocytes**
CONCLUSIONS

Diet supplementation with 18:0 does not prove useful to alleviate FO-induced MFD in dairy ewes. This result cannot be fully accounted for by the low digestibility coefficient of supplemental 18:0 and challenges the theory of a shortage of this FA as a mechanism to explain fish oil-induced MFD in sheep.

It is therefore hypothesised that increases in the concentration of some candidate milk fat inhibitors might play a more relevant role in this type of MFD.
THANK YOU VERY MUCH FOR YOUR ATTENTION!